

The Relationship Between Tropopause Cirrus and Deep Convection

**Steven Massie, Cheryl Craig,
Rashid Khosravi, John Gille (NCAR)
John Barnett (University of Oxford)**

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Outline



Motivation: Cirrus near the tropopause takes part in the physical processes that dehydrates air that enters the lower stratosphere

How is cirrus formed?

Blow-off from deep convection

In-situ formation by isolated rising humid layers

Cold temperature perturbations of dynamical waves

How does each process (in a % relative basis) contribute to cirrus formation?

Use HIRDLS , Calipso-CloudSat, and NOAA OLR data to relate cirrus to deep convection

Analysis includes back trajectory calculations

Example of isolated cirrus



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|-----700 km-----|

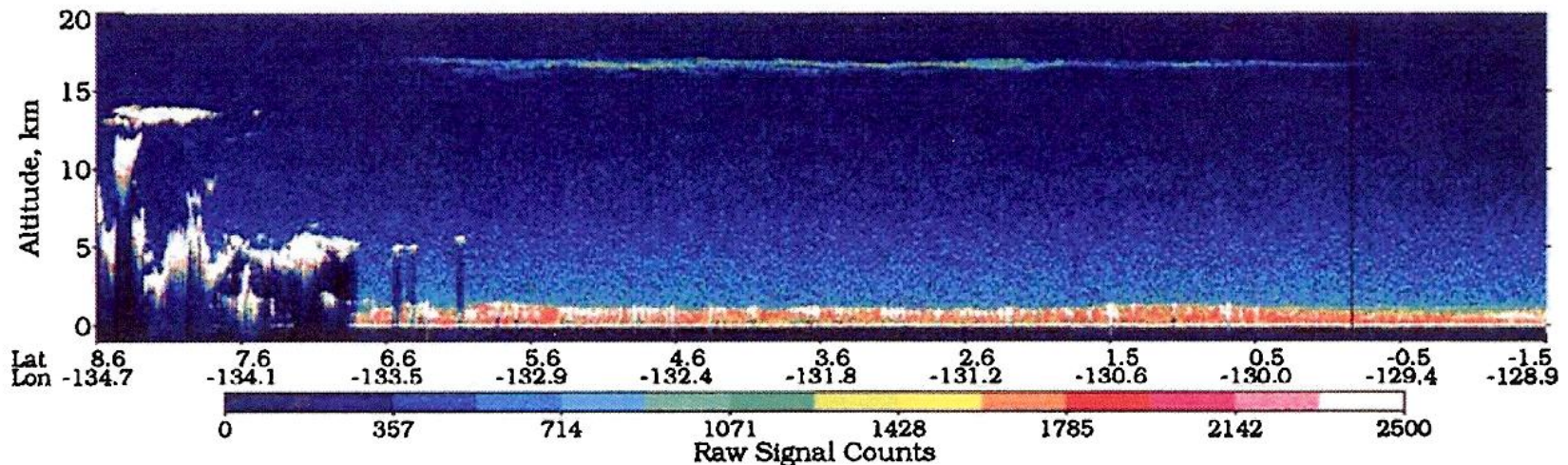


Plate 1. Cross-section of color-coded raw backscatter signal from the LITE 532 nm channel over the western Pacific Ocean. White indicates dense clouds or the ocean surface return, dark blue indicates clean atmosphere, reds and greens generally indicate aerosols. Laminar cirrus is seen at an altitude of 17 km.

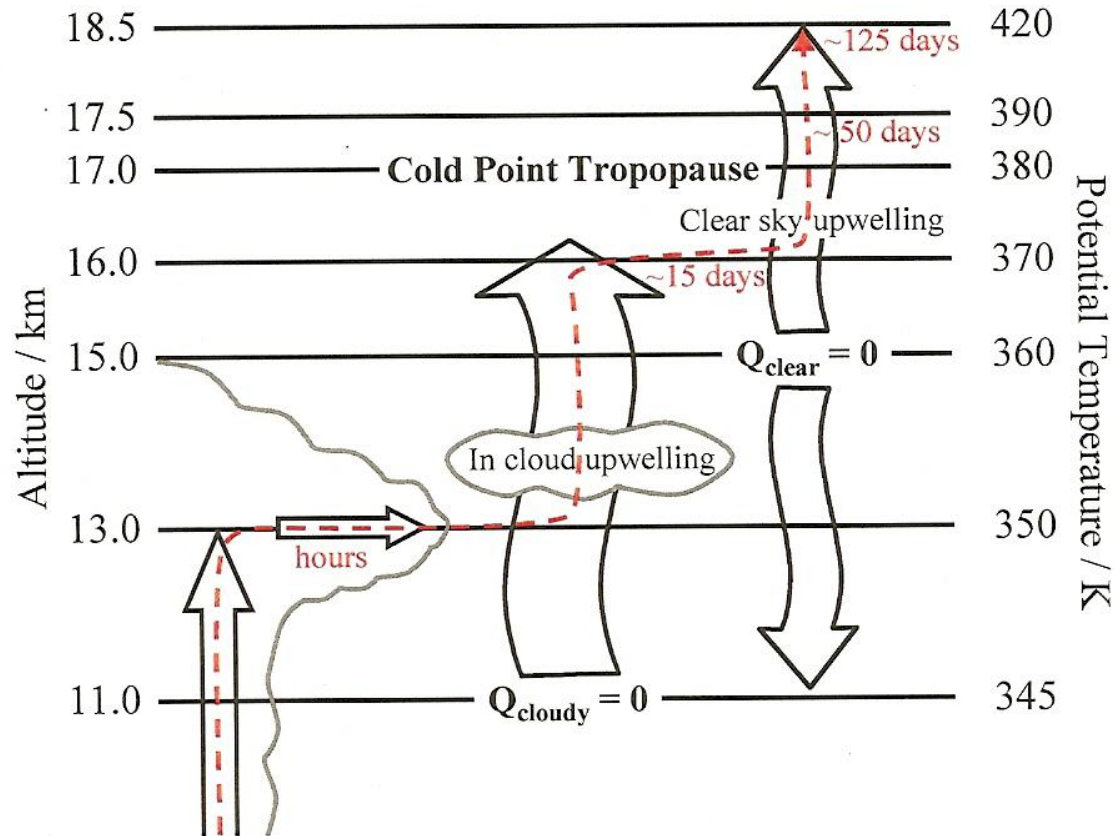
Winker and Trepte, Laminar cirrus observed near the tropical tropopause by LITE, Geophys. Res. Lett., 25, No 17, p3351, 1998.

September 1994 shuttle flight

Maximum outflow is at 13 km



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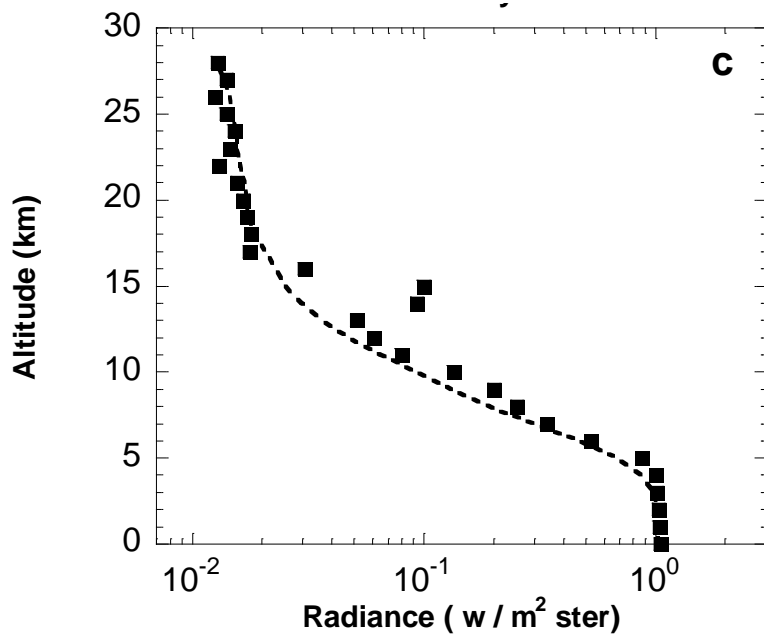
Corti et al., The impact of cirrus clouds on tropical troposphere-to-stratosphere transport, Atmos. Chem. Phys., 6, 2539-2547, 2006.

HIRDLS Cloud Types

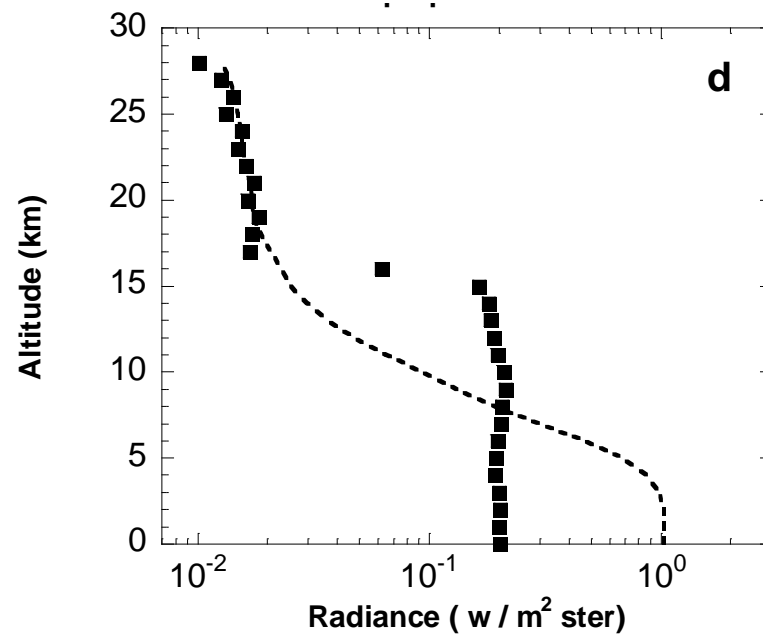


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Cirrus Layer



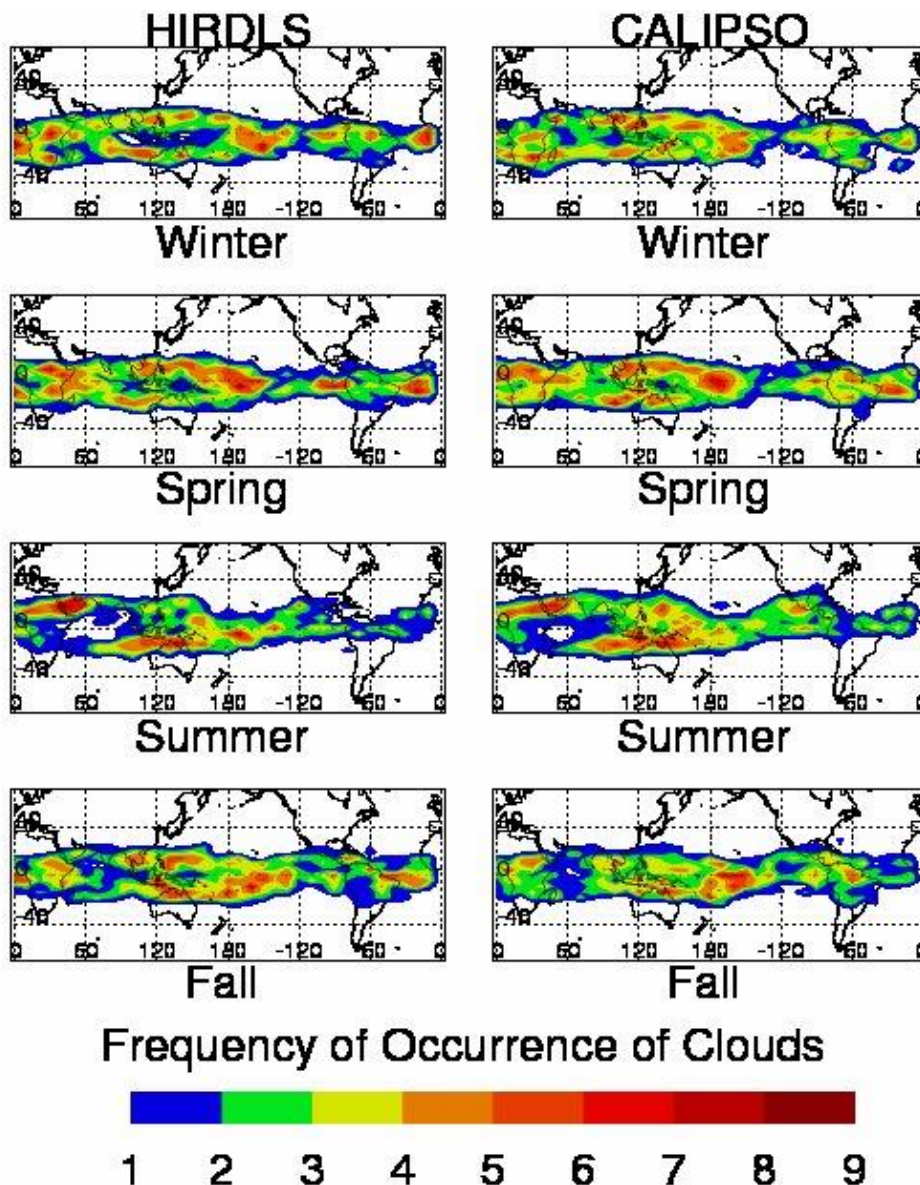
Opaque Cloud



... Clear sky average



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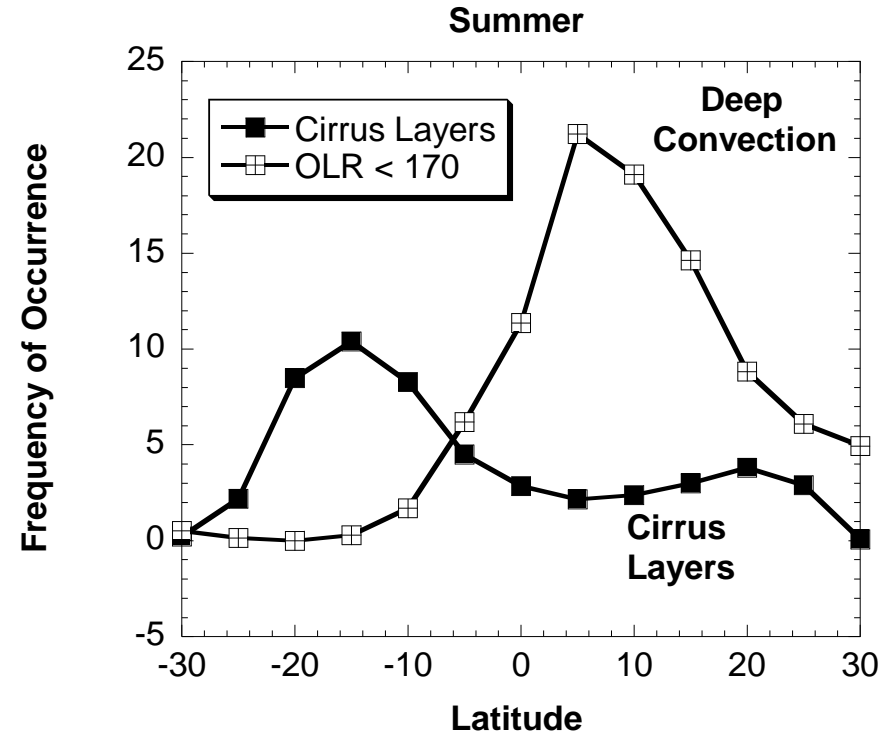
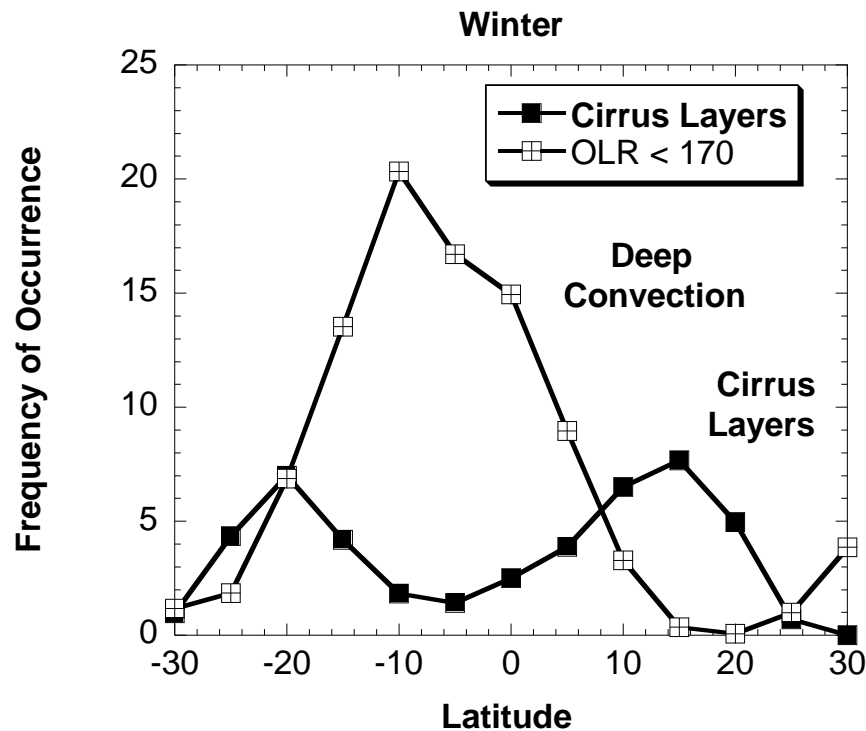


**Geographical
distribution of
isolated cirrus
at 121 hPa
($z \sim 15$ km)**

**Isolated cirrus
has a vertical
depth ~ 1 km**

**These observations
represent new
capabilities**

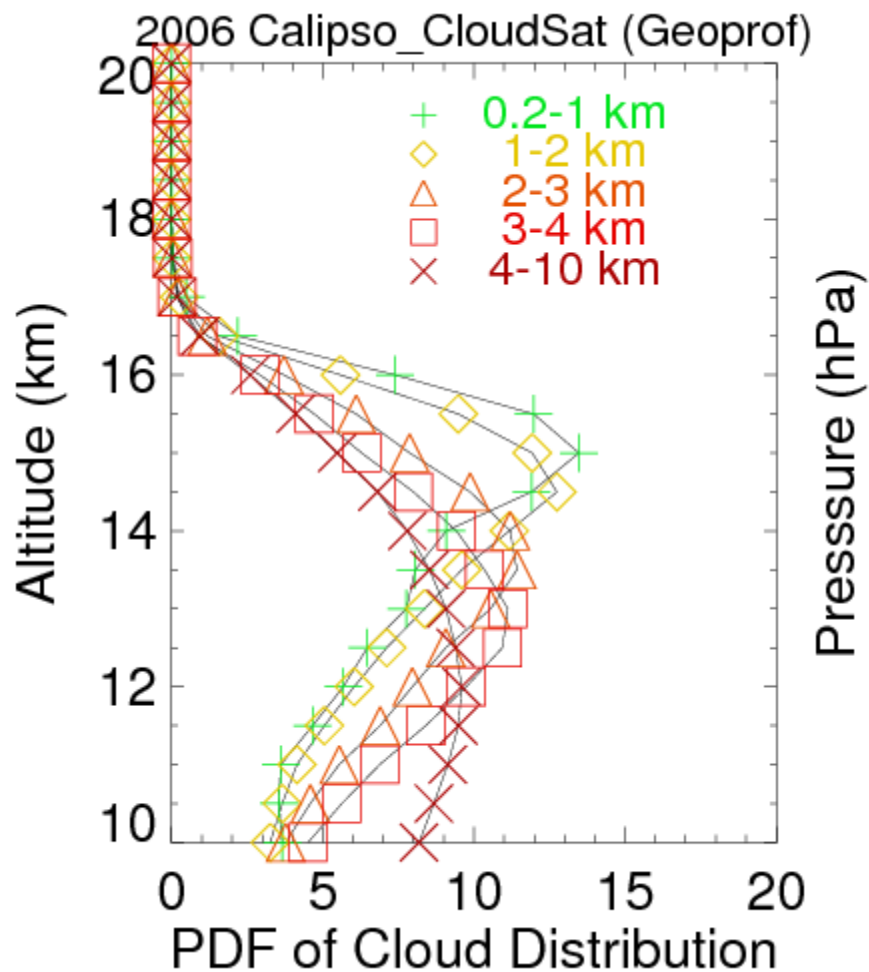
Isolated Cirrus is away from deep convection



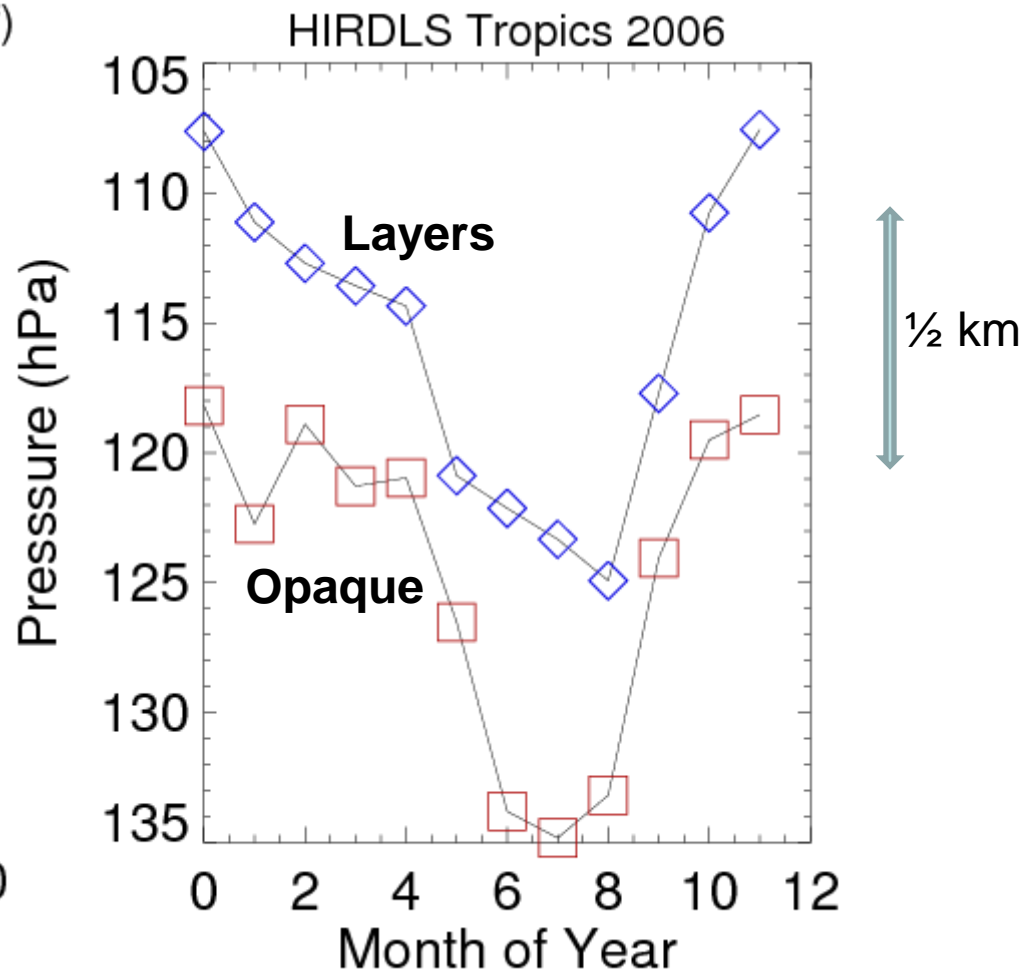
**HIRDLS Cirrus at 121 hPa
100 – 140 longitude**



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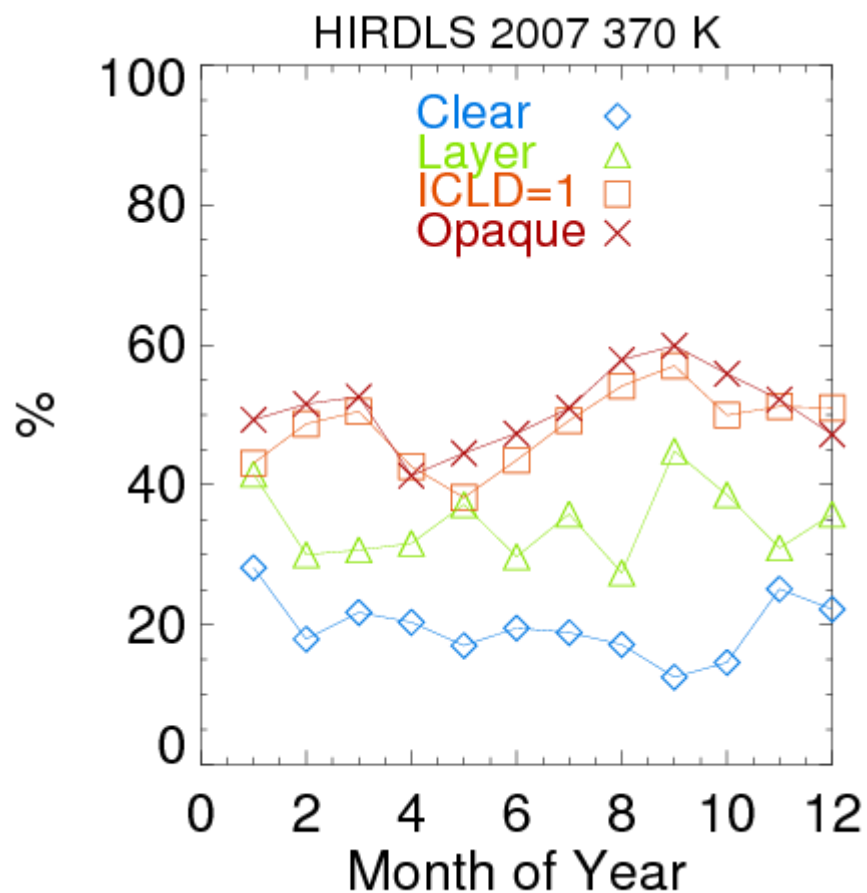
**Normalized distribution of clouds
for full altitude range of each layer**



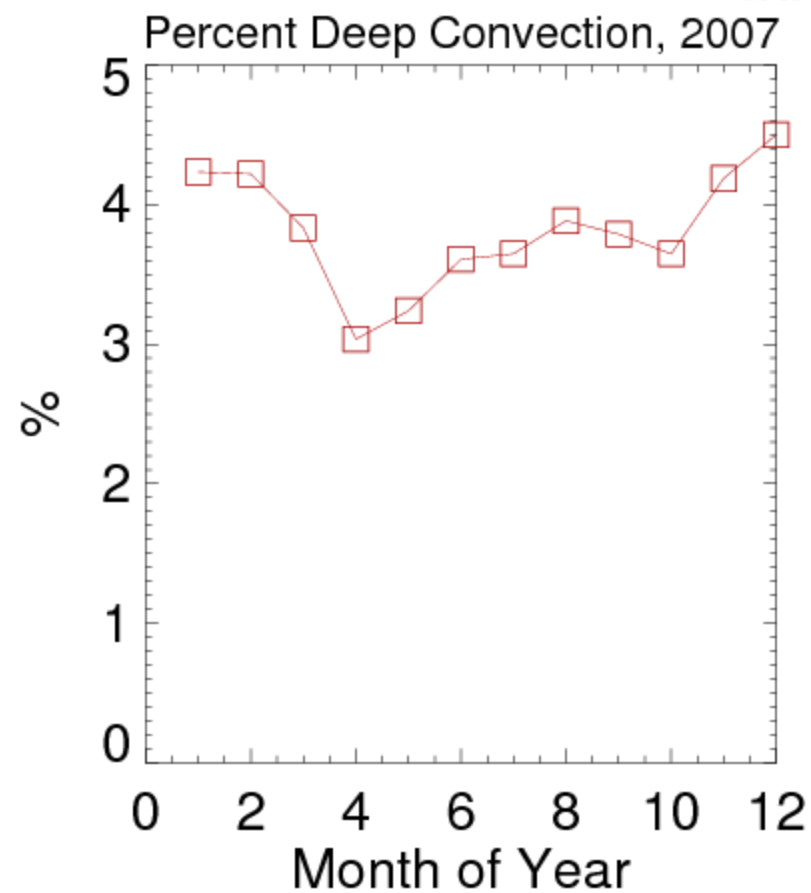
Average pressure of cloud tops throughout the year



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Percent of time that a 5 day back trajectory encounters deep convection

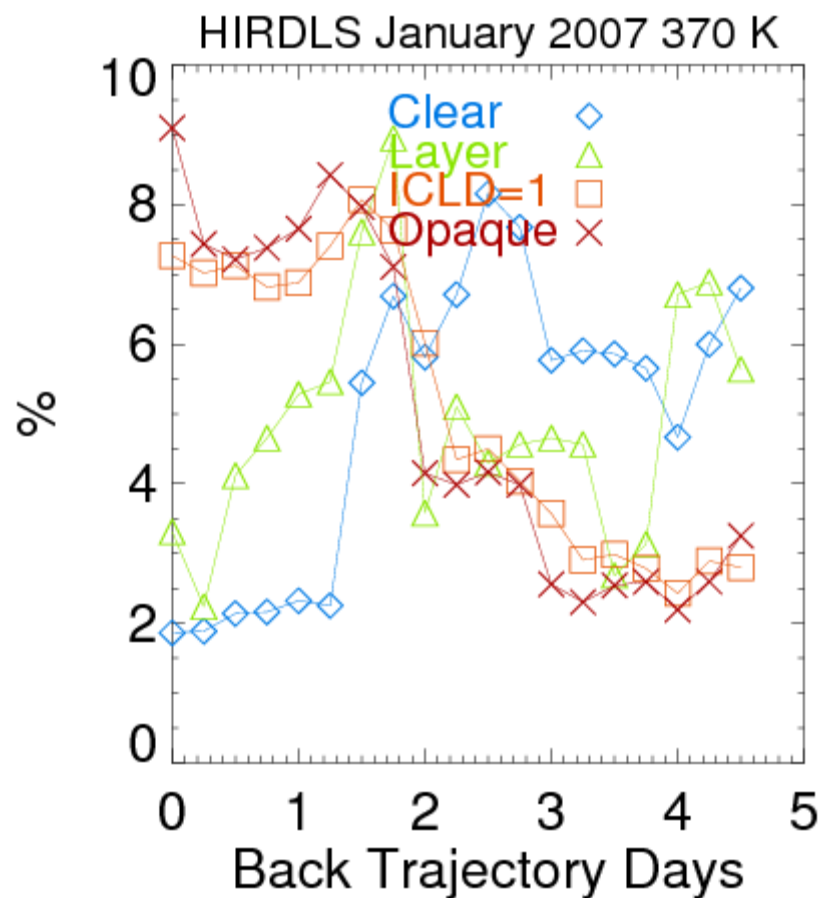
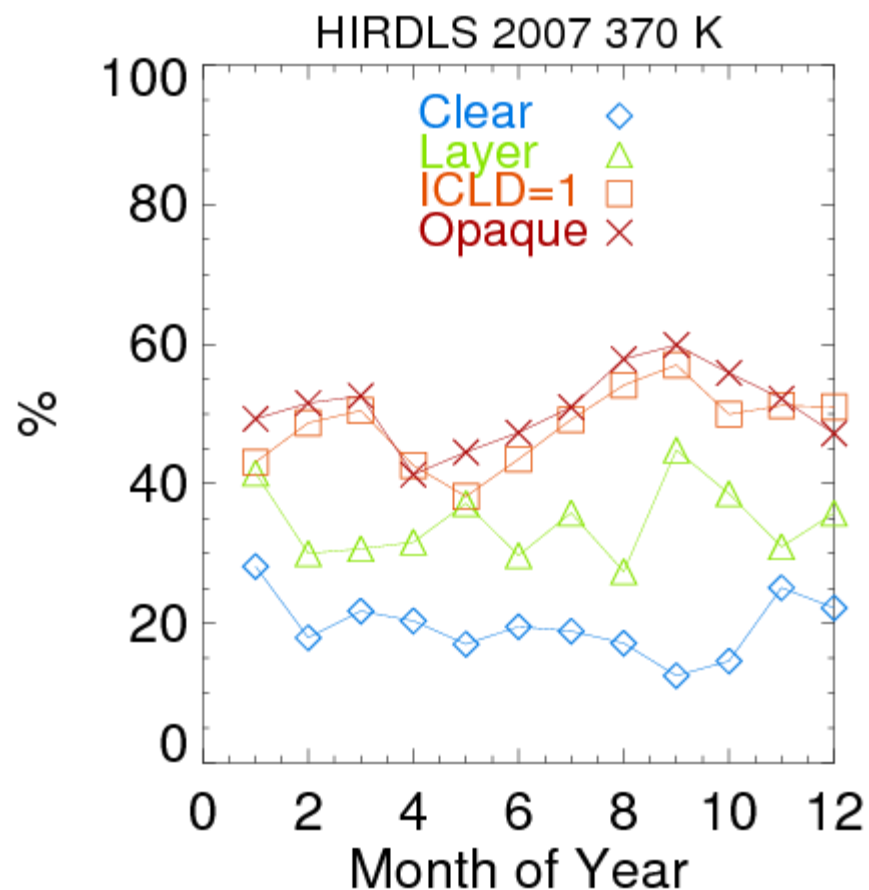


Percent of the time that deep convection occurs in the tropics for OLR 170 w m⁻², 30 S - 30 N

Opaque curve is correlated with Percent Deep Convection curve



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Layer curves have character between clear sky and opaque cases

Conclusions

Isolated cirrus layers are located preferentially away from deep convection

Cirrus layers near the tropopause are located above thicker cloud structures

Back trajectory calculations suggest that isolated cirrus layers are associated with deep convection 33% less often than thicker cloud structures at 370 K (121 hPa)